

AD-A262 621



2

1992
Executive Research Project
DIS10

DTIC
ELECTE
MAR 30 1993
S C D

Baseline Study Telecommunications

Commander
James H. Hoffman, USN
U. S. Navy

Faculty Research Advisor
Lieutenant Colonel Cecilia C. Albert, USAF

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited



The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-6000

20001013170

98 3 29 029

93-06362



SPDX

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION / AVAILABILITY OF REPORT Distribution Statement A: Approved for public release; distribution is unlimited.	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A		4. PERFORMING ORGANIZATION REPORT NUMBER(S) NDU-ICAF-92- DIS 10	
5. MONITORING ORGANIZATION REPORT NUMBER(S) Same		6a. NAME OF PERFORMING ORGANIZATION Industrial College of the Armed Forces	
6b. OFFICE SYMBOL (If applicable) ICAF-FAP		7a. NAME OF MONITORING ORGANIZATION National Defense University	
6c. ADDRESS (City, State, and ZIP Code) Fort Lesley J. McNair Washington, D.C. 20319-6000		7b. ADDRESS (City, State, and ZIP Code) Fort Lesley J. McNair Washington, D.C. 20319-6000	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	
8c. ADDRESS (City, State, and ZIP Code)		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
10. SOURCE OF FUNDING NUMBERS		PROGRAM ELEMENT NO.	
PROJECT NO.		TASK NO.	
WORK UNIT ACCESSION NO.		11. TITLE (Include Security Classification) Baseline Study Telecommunications	
12. PERSONAL AUTHOR(S) James H. Heffman, USN		13a. TYPE OF REPORT Research	
13b. TIME COVERED FROM Aug 91 TO Apr 92		14. DATE OF REPORT (Year, Month, Day) April 92	
15. PAGE COUNT 57		16. SUPPLEMENTARY NOTATION	
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD		GROUP	
SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) SEE ATTACHED			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Judy Clark		22b. TELEPHONE (Include Area Code) (202) 475-1889	
		22c. OFFICE SYMBOL ICAF-FAP	

J. L. Man
DIS 10

ABSTRACT

Baseline Study. Telecommunications: This is a vertical study of the companies which produce radio-communications equipment. Structure, conduct and performance of this segment of the telecommunications industry are presented. Structure consists of diversification, number of sellers, number of buyers, percentage of government sales, entry barriers, sufficiency of the number of firms to service DoD, marketing and distribution, overseas companies, applicability of information support technology and trade associations. Conduct deals with pricing policies, buying practices of consumers, management practices, labor practices, government intervention, research and development, general attitude, management strategies, capital investment and mergers and acquisitions. Performance includes trends in sales, quality of products, export competitiveness, protection from foreign competitors, response to DoD cuts, environmental concerns, legal problems and financial performance. Several standard financial measurements are provided.

1992
Executive Research Project
DIS10

Baseline Study Telecommunications

Commander
James H. Hoffman, USN
U. S. Navy

Faculty Research Advisor
Lieutenant Colonel Cecilia C. Albert, USAF



The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-6000

Accession	For	
NTIS	CRA&I	<input checked="" type="checkbox"/>
DTIC	TAB	<input checked="" type="checkbox"/>
Unannounced		<input checked="" type="checkbox"/>
Justification		
By		
Distribution /		
Availability Codes		
Dist	Avail and/or Special	
A-1		

DISCLAIMER

This research report represents the views of the author and does not necessarily reflect the official opinion of the Industrial College of the Armed Forces, the National Defense University, or the Department of Defense.

This document is the property of the United States Government and is not to be reproduced in whole or in part for distribution outside the federal executive branch without permission of the Director of Research and Publications, Industrial College of the Armed Forces, Fort Lesley J. McNair, Washington, D.C. 20319-6000.

COMMUNICATIONS INDUSTRY

INTRODUCTION

Communications are the glue that holds a modern military effort together. The complexity of joint operations is not possible without rapid, reliable and secure communications. Fleet operations of Naval forces can be ineffective without communications links. Communications are just as important to the logisticians who support the "sinews of war" as it is to the pilots, sailors or soldiers/marines who meet the enemy head on. Yet some state-of-the-art intelligence collection systems do not achieve the results they were designed for because the information cannot be transferred in a timely manner to the commander who requires it. Moreover, interoperability between the services has been a long standing goal, but has not yet been adequately achieved.

The recent conflicts in Grenada, Panama and in the Mideast surfaced both problems and successes in communications. I will not speak to this subject, but, rather to the questions of where we obtain this critical equipment, and how the industry that provides equipment and innovation will continue to meet the needs of the American military.

I do not approach this task completely without bias. I have great faith in American industry, and do not agree with a great deal of the criticism that has been foisted on a significant part of our culture. The men and women on the factory floor are no better, and certainly no worse, than the troops that have been lauded for their effort in the Gulf War. The managers who are being routinely criticized are of the same mold as those of us who fill the ranks of the senior officers of the military services. My personal experience has found as many dedicated civilians as officers in acquiring the tools of war. I have also known people

who placed themselves first, in uniform and in three-piece suits; careerism and greed are not really very different.

I will attempt to show the reader the present status, capability, and trends, searching for the future in an industry necessary to support the common defense of the United States.

Approach

The purpose of this paper is to conduct a baseline study of a segment of the telecommunications industry. I have decided to study that group of companies which produce communications equipment, specifically communications receivers, transmitters and transceivers. This segment of industry is critical to the Department of Defense. All services use radio communications equipment for a vast range of purposes. The frequency range from extremely low to optical has been exploited for military use. A significant question is whether the military services will be able to continue to procure quality radio equipment as defense budgets decline and as U.S. industry goes through a period of major structural change.

By focusing on a specific segment of the telecommunications industry, I will be able to accomplish a more thorough vertical study of American industry. The Standard Industrial Classification (SIC)-code of the segment I am studying is 3663, Radio and television Broadcasting and Communications equipment, and Other Communications Equipment, SIC code 3669. It is very difficult to study such a broad area as telecommunications and information systems and make any determinations which are specific enough to be valid. Generalities in such a broad industry, consisting of so many large corporations become meaningless. Hopefully, more useful results will be obtained by studying a more specific area.

This paper will investigate the structure, conduct and performance of this segment of industry. Structure considers the following:

- Diversification

- Number of sellers
- Number of buyers
- Percentage of government sales
- Entry barriers
- Are the number of firms sufficient to service DoD?
- Marketing and distribution
- Overseas companies
- Makeup of the labor force
- Applicability of information support technology
- Trade associations

Conduct deals with the following:

- Pricing policies
- Buying practices of consumers
- Management practices
- Labor practices
- Government intervention
- Research and development
- General attitude
- Management strategies (long term versus short term)
- Capital investment
- Mergers and acquisitions

Performance is concerned with:

- Trends in sales
- Quality of products
- Export competitiveness
- Are the companies asking for protection from foreign competitors?

- How is the private sector responding to DoD budget cuts?
- Environmental concerns
- Legal problems
- Financial performance

I will provide information on many of the above elements of the industry segment studied. In some areas information is difficult to obtain, but important conclusions can be gained from those areas where data is available.

Definition of the Industry

I have chosen a specific grouping of companies to study in order to define this industry. These companies either presently produce radio equipment or have the capacity to produce products required by DoD. I have not chosen an exhaustive list, but feel the sample chosen will answer the questions important to a military perspective. The companies which will be examined in detail are:

IBM

Raytheon

Motorola

Boeing

Rockwell International

E-Systems

Litton

Westinghouse

ITT

Harris

A few other companies may be mentioned, but will not provide as many details.

Other firms could be included, such as Loral, TRW or Hughes, but information is not readily available, and the results would not change significantly.

The radio communications industry is on the forefront of technology. "According to Army officials, modern communications systems will use wide bandwidth fiber optic cable and millimeter wave technologies to interconnect local area networks. Adaptable and programmable modulation schemes are planned to avoid threats and for allied systems interoperability, Army officials contend."¹

"For all the heralded success of U.S. high technology weapons in operation Desert Storm, the less glamorous area of battlefield communications displayed some troublesome weaknesses, Defense officials say. One such weakness is the difficulty the services encountered in communicating with one another using different, incompatible radios. This chronic problem previously was exposed in the Grenada and Panama conflicts. Compounding this interoperability issue, the Gulf War spotlighted the need for communications compatibility with an extensive list of allies. This included some unlikely partners, typifying the unpredictability of contemporary world politics. Simply deploying enough radios for joint/combined interoperability is not the answer, the officials continue. The physical and logistical burden would immobilize many tactical platforms, they add.

Another weakness is that many of the U.S. military's most operationally important radios--even some touted as being jam resistant--suffered from inadequate interference tolerance. This is a reflection of technology limits that existed when the radios were designed, the officials contend. In addition to being susceptible to enemy electronic countermeasures of modest sophistication, the radios often cannot handle mutual interference, especially from nearby friendly force radios.

Finally, these officials contend, virtually none of the fielded radios has adequate resistance to signal interception and exploitation by a sophisticated enemy.

The Speakeasy system is designed to be compatible with 15 radios fielded by the U.S. and its allies. This system is in advanced development. As originally structured, the program is slated for full-scale engineering development by the year 2000."²

An important initial finding of this study is that radio equipment for DoD is produced by a relatively small number of major companies; it is not procured from small companies in any large quantity.

STRUCTURE

Diversification

Companies that produce radio communications equipment for the Department of Defense, in general, are large businesses. Most are primarily electronic manufacturers, selling a wide range of products. Some fabricate semiconductors, especially special purpose integrated circuits. A few of the companies make larger systems, for example, Boeing is known as the preeminent aircraft company in the world. Litton is a major shipbuilder.

Motorola reentered the marine VHF radiotelephone market with the introduction of the Radius^RTritonIITM ship station radios. The Radius line of two-way radios was broadened with trunked mobiles for Canada and Latin America.³ "We introduced the latest model of our Lightweight Satellite Terminals. The LST-5C radio provides full power to establish and maintain a worldwide satellite communications link with the use of only a lithium battery."⁴ Further, a secure telecommunications business unit is being established. It produces equipment that protects information transmitted over voice and data networks for both commercial and government market, including the SECTELTM Secure Telephone Unit.⁵ Motorola has diversified within the communications area.

Electronics continued to be Raytheon's largest business segment with sales of \$5.517 billion or 59.5% of total sales.⁶ For Rockwell, electronic sector earnings increased and comprised 48% of the total before unusual items. Electronics contributed 39% of total sales and continued to be the largest sector. Electronics businesses include Allen-Bradley Industrial Automation, Avionics, Telecommunications activities in digital communications and specialized switching systems, and Defense Electronics.⁷ Rockwell states, "Our SAT-900

satellite communications system has been certified and delivered to 10 major airlines. It is in revenue service, providing improved communications and position information for aircraft flying transoceanic routes. Extension of avionics technology to new markets continues in Railroad Electronics, where we began the integration of in-cab electronics, with deliveries to Norfolk Southern and Union Pacific; and in Mobile Communication Satellite Systems, where road tests are underway with CRST, a major trucking firm."⁸

At Westinghouse, Electronic Systems has long been a premier supplier of advanced electronic systems to the Department of Defense. The group is moving to expand in complementary commercial markets such as air traffic control, home security, aircraft power generation and drug traffic interdiction.⁹

Since the mid-1980s, Harris has pursued a strategy of diversifying beyond defense markets to sustain its growth over the long term. The strategy is working. "We've won big programs involving information processing and communication systems for applications as diverse as air traffic control, space exploration, metro transit and prisons," says Allen S. Henry, president of Harris' Electronic Systems Sector. Some of the largest revenue growth during the past two years has come from the FAA and NASA.¹⁰ In 1989 the Corporation decided to exit a significant portion of its data-communications and computer-based office systems business.¹¹

IBM says, "The information processing industry is still very much a growth industry--and will continue to grow more rapidly than most other industries over the next five to ten years. The industry is rapidly changing. First, there has been a perceptible shift in customer focus from hardware toward software and services. Second is competition, both in the number of competitors and the ferociousness with which they compete. Third, technology has improved so much that today we need less capacity--both in plant and personnel--to produce the same volumes as we did just two years ago. As a result, there is excess capacity

throughout the industry. Add an uncertain economic environment, and you have a tough business climate."¹²

Diversification is a major issue to the companies in my area of interest. This includes products and markets. It appears to be a strength, not a weakness. Most companies see diversification as necessary for survival in the decade of the '90s. This diversification will reduce DoD leverage on this industrial segment.

Number of Sellers

The segment of industry that produces communications hardware is moderately concentrated. I am studying ten firms in detail and will mention a few others. According to the Bureau of the Census, U.S. Industrial Outlook, "Ten to 15 U.S. firms continued to dominate shipments by the radio communication and detection equipment industry. Many firms announced significant layoffs in response to declines in orders from the U.S. military. However, many of the planned layoffs were delayed pending the outcome of the Persian Gulf crisis. Business acquisitions and mergers continued as companies that had been dependent on U.S. military contracts sought to diversify."¹³

Number of Buyers

The U.S. federal government is the single largest buyer for this industrial area. State and local governments are also important. But, more than half of the equipment is sold to commercial and global customers. Motorola's Land Mobile Products--The Land Mobile Products Sector--designs, manufactures and distributes two-way radios and other forms of electronic communications systems for a wide range of customers including agriculture; commercial; construction; education; state, local, and federal government; and health care markets; as well as for industrial, mining, petroleum and transportation companies and utilities.¹⁴

This topic will be covered in greater detail in other sections of this paper.

Percentage of Sales to the Government

Growth in the industry will continue to be driven by the U.S. Government, especially military, contracts. International trade, although growing, is presently of minor importance to the industry. Product shipments by the industry rose about two percent in constant dollars, to about \$59.8 billion. Although no current data are available, shipments to Federal Government agencies are believed to account for nearly half of total shipments.¹⁵ The defense share of the output in Radio and TV communication equipment was 35.7% in 1990 and is projected to decline to 31.2% in 1994.¹⁶

Motorola states, "The Government Electronics Group specializes in research, development and production of electronic systems and equipment for the Department of Defense, NASA and other U.S. government agencies, commercial users and international customers."¹⁷ "Sales rose 8% to \$3.6 billion and orders increased 9%. Order growth in the US was led by radio common carrier and federal government markets. Internationally, orders grew most rapidly in the Asia Pacific region."¹⁸

Raytheon reports that in the Electronics segment sales were \$5.5 billion and pre-tax profits were \$667 million, both up over 1989. Government electronics continued to lead the segment.¹⁹ During the year (1990) the US Navy awarded Raytheon a contract for low-rate initial production of Navy EHF Satellite Program terminals. The Air Force Military Strategic Tactical And Relay (MILSTAR) satellite terminal program also received funding for new engineering development work. The MILSTAR program is to be restructured to emphasize tactical communications requirements as directed by Congress at the end of the year. As part of this restructuring, present MILSTAR terminal production will be supplemented by a new miniature EHF satellite terminal program for which Raytheon should be a prime competitor. MILSTAR-related programs will provide the nation with a global, satellite-based, highly secure, jam-resistant communications capability.²⁰

Boeing, as stated earlier, is primarily an aircraft manufacturer. The company created Boeing Computer Services (BCS) to support the company's need for computing and telecommunications services. This entity has been allowed to solicit outside business, and was selected to provide the Naval Weapon's Center, China Lake, with a full range of information services.²¹

To quote Litton, "Fiscal year 1991 was marked by the same trend we have seen developing over the last two years, namely that Litton's emphasis on its commercial activities has become the driving force behind the overall growth of the corporation. Litton expects the gains in a couple of commercial sectors to offset the weaknesses in their defense electronics activities in coming years."²² Further, about 47%, 45% and 47% of the sales and service revenues of the Company for the years ended July 31, 1991, 1990, and 1989 respectively, were from U.S. Government contracts and subcontracts. Approximately 90% of these revenues for 1991 related to fixed-price type contracts.²³

For Harris, the company continues to expand in international markets during the year, with overseas sales rising to 30% of the corporate total from 28% last year. U.S. Department of Defense sales were 25% of the corporate total, sales to other U.S. government agencies were 11% and commercial sales were 64%.²⁴

Figure 1 shows the ratio of overseas sales to total sales of the companies studied in this report. Most of the companies sold six percent or less to foreign customers in the years shown. Boeing and IBM were more active globally.

Entry Barriers

The entry barriers for this high tech area of telecommunications are not unique. A relatively large investment is required for the material and human resources required to be competitive. Entry would be simple for a company already producing some type of electronic equipment, but the technical requirements for equipment that sends and receives radio frequency energy are complex and must meet stringent requirements set by governments

and international bodies. There are significant markets for these products, but growth is slow compared with other areas of electronics. It appears that few companies are trying to enter this segment because other areas are more profitable and less regulated.

One important area of change offers the potential for economic stimulus, particularly in manufacturing productivity and competitiveness. The current capital gains tax continues to make it difficult for business, especially start-up companies, to obtain venture capital. Obviously new businesses cannot enter the market without capital, and established firms are finding it difficult to invest in innovation and capital expansion. Consequently, the high costs of borrowing funds, which are double the costs of capital in Japan, together with restrictions of deductibility of independent research and development costs, have slowed the pace of technological change and innovation in the U.S.²⁵

Is the Number of Firms Sufficient to Service DoD?

The answer to this question is straightforward. Present companies can easily meet defense requirements. As the DoD budget falls, overall demand will, at most, be flat for radio communications equipment. The present industry structure provides a wide range of products, with adequate competition.

Marketing and Distribution

By the nature of the product being studied, marketing and distribution do not offer any particular problems. The equipment, for the most part, is small enough to be delivered by virtually any means. Most large communications systems can be broken down into small enough parts to be carried by one person. Some defense equipment may have security constraints, but standard systems, such as the COMSEC Material System, exist to allow necessary distribution controls and channels.

Marketing of commercial and defense systems is similar. Customers either have a need, or they don't. Successful sales are often initiated by the potential customer. Aggressive salespeople and expensive advertising are unnecessary for most of the products in

this segment. A notable commercial exception would be cellular telephone systems which are quite competitive.

Overseas Companies

Many of the companies in this area have foreign subsidiaries, along with other types of ties, weak and strong. Joint ventures have been made with foreign companies. Raytheon acquired companies in Spain, Scotland, England and Canada in 1990.²⁶ At ITT, "During 1990, to better serve the significant European market and meet its future challenges and opportunities post-1992, we reconstituted a Board of Directors for ITT Europe. European sales and revenues of \$5.6 billion in 1990 represent over 25% of our total revenues."²⁷ At Harris, several acquisitions were made during the year to expand product strength in growth markets. They included the purchase of TVT, a United Kingdom-based manufacturer of television and radio transmitters and other broadcast equipment. The TVT operation is the Communications Sector's first overseas manufacturing facility and it will serve as a base for the sector's further expansion in international markets.²⁸ The companies in this segment have a great deal of experience in global operations and their competitiveness internationally will be discussed later.

Applicability on Information Support Technology

None of the documents I have obtained directly address this area of the industry structure. The companies in this segment sell equipment and services in the automated information services area. It seems reasonable to assume they are capable of using the technology for a wide range of purposes; from automated manufacturing to computer assisted decision support systems. Management is certainly aware of the capabilities available. The primary mission of Boeing Computer Services will remain one of providing computing and telecommunications support for the company's operating units. The external business focus will be confined to seeking contracts for the integration of information services to government and commercial customers.²⁹

Trade Associations

There are a number of trade associations with interests in the radio communications area. For example, the:

- Electronic Industries Association (EIA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Armed Forces Communications and Electronics Association (AFCEA)
- Communications Marketing Association
- Telecommunications Association
- Computer and Communications Industry Association

IEEE and AFCEA are professional organizations interested in a wide range of topics, many related to technology.

By far the most important industry association is the EIA. The current mission statement of the EIA is, "Dedicated to the competitiveness of the U.S. electronics producer".³⁰ In 1990 the EIA sponsored 1,037 committee meetings, subcommittee meetings, seminars and industry forums with 15,700 industry participants in attendance. That doesn't include 14 major trade shows and international exhibitions such as the two highly successful consumer electronics shows. These two shows alone had an attendance total of more than 126,000 people.³¹ The EIA sponsors a wide range of efforts aimed at enhancing the electronics industry. Within the framework of defense spending reductions, the DoD is relying more and more on non-government standards, i.e., industry standards, to fulfill their acquisition needs. As a result, a number of EIA's engineering committees have been developing their standards and specifications with both the commercial as well as military needs in mind. A major effort is underway in the EIA's Soldering Technology Committee to develop an industry replacement for MIL-STD-2000—a basic standard dealing with soldering.³²

CONDUCT

Pricing Policies

From the resources available I was unable to draw any conclusions about pricing policies. With sufficient producers to allow competition, economic considerations drive pricing.

Buying Practices of Consumers

Customers for these products often have a good idea about the technical capability they are looking for. Often the manufacturer must meet stringent performance characteristics and design criteria specified by the buyer. This applies to commercial as well as defense customers. End products are highly differentiated, and customers are willing to pay more for something which most closely meets their requirements.

The Defense customer historically bought communications equipment with detailed specifications and standards. New procurement approaches may alter this somewhat, but communications must meet certain military requirements for ruggedness and interoperability. It would be a great breakthrough if the military services and defense agencies would describe what they want rather than how to make it.

Management Practices

Management in the communications segment, in general, meets world class standards. At Motorola, "In striving to achieve our fundamental objective of Total Customer Satisfaction, we will focus on giving our worldwide customers what they want, when they want it, with Six Sigma quality."³³ At Raytheon, "Our greatest strength is our people. So many times in our company's history, Raytheon people have come through at the critical moment. They have been doing so again, supporting the allied coalition in the Middle East."³⁴

Rockwell says, "Internal improvement may also follow many different routes, including: Total Quality Management, Continuous Process Improvement, reducing cycle

times, improving organizational structure and processes, enhancing teamwork, and benchmarking.³⁵ Our commitment to Leadership Performance taps the full potential of Rockwell's people--their skills, knowledge, creativity and driving desire to be the best--thus fulfilling the company's promise of long-term business growth and strong financial performance.³⁶ "Tucked away in the mountains near our Rocketdyne Division is a 'school' where experienced Rockwell, customer and supplier executives, managers, supervisors and production personnel are attending two-day sessions as part of our company-wide drive for continuous process improvement, or CPI. The sessions are called the CPI 'Boot Camp' and usually involve a group of 16 individuals representing a cross-section of their organization or division. Through hands-on exercises in a process which duplicates a factory production flow, they learn to analyze work situations in a way that identifies opportunities for process improvement."³⁷

This citation is found in the Harris Annual Report: "Through our 'Quality First' initiative we are building an environment that encourages every employee to make full use of his or her individual creativity."³⁸ Harris expands, "Our company-wide focus on reducing the time from new-product conception to market introduction is producing some excellent results. Increasingly, new-product cycles are measured in months instead of years, and in some cases they are now being counted in weeks. We are using cross-functional teams to achieve these product-to-market improvements. Representatives from marketing, engineering, manufacturing and other relevant functions, including suppliers, are all involved at the start of a new project as members of a dedicated team. Most importantly, customer representatives are invited to join these teams at the earliest stage of new product development. Quality First is a top-down, bottom-up culture change that applies to every facet of our business and involves everyone at Harris."³⁹

More than half of IBM's employees throughout the world already have received some education on market-driven quality; IBM reports progress in putting its principles to work.

IBM's development and manufacturing site in Rochester, MN, earned major recognition for its quality focus when it won the Malcolm Baldrige National Quality Award.⁴⁰

At the EIA, the Human Resources Council (HRC) continued to promote opportunities to enhance the competitiveness of the U.S. electronics producer by focusing on the creation of a "World Class Workforce". In addition, the HRC examined skyrocketing U.S. health costs and their effects on electronics manufacturers. Human Resources executives identified total quality management as the key to survival in global markets. Corporate assessments of total customer satisfaction and total cycle time within the electronics industry revealed the importance of employees dedicated to quality improvement. EIA's Quality and Reliability Engineering Committee is working on a National Electronic Process Certification Standard that will encompass the basic concepts and requirements of Total Quality Management.⁴¹

Most of the companies I have studied have embraced the competitive management practices invented in the U.S. and proven in Japan. The degree of success and level of commitment varies, but virtually all are trying, and have achieved some success. Management of the companies in this segment is probably better than that of any other industry in the U.S.

Labor Practices

There are a number of labor unions with memberships in the plants and factories in the radio communications industry. A few are:

- The International Brotherhood of Electrical Workers
- The Communications Workers of America
- The International Union of Electronic, Electrical, Salaried Machine and Furniture

Workers

Government Intervention

Technically, the Federal Communications Commission provides detailed control over all electrical and electronic equipment which radiates electro-magnetic energy. This

constrains equipment which can be produced and limits possible features. This regulation is acceptable, since an unregulated environment would allow interference which would limit usefulness of radio communications equipment for potential customers. Government and industry have a fairly open relationship. The subject of government regulation of communications is a study in itself.

Research and Development

This industry is heavily committed to research and development. As a percent of sales, Motorola continues to invest slightly less than 10% of every sales dollar in product development and technological advances.⁴²

At the Advanced Device Center, Raytheon scientists and engineers advanced the state of the art in integrated circuit microfabrication--designing, developing, and manufacturing gallium arsenide-based monolithic microwave integrated circuits (MMICs) as well as silicon-based very-high-speed integrated circuits (VHSICs). During the year, Raytheon satisfied Department of Defense requirements for validating the company's pilot line to produce gallium arsenide MMICs, achieving a major milestone under the Microwave/Millimeter Wave Monolithic Integrated Circuit (MIMIC) program for which Raytheon and Texas Instruments have a joint venture.⁴³

Boeing invested about \$1.6 billion during the year in new equipment and facilities, and more than \$800 million for research and development.⁴⁴

Rockwell states, "By adding other technical bases like 'fuzzy logic' computer programs, which resemble human decision-making processes, and neural network vision systems, we are also exploring ways in which our technology might contribute to a future generation of 'intelligent' vehicles, greatly improving highway safety and reducing driver fatigue."⁴⁵

"IBM makes enormous investments in research and development to stay ahead of the competition. The competitiveness of our products depends on our ability to get to the

marketplace early with the newest technology. Development efforts require strong investments both in physical and intellectual resources as development cycles are getting more complex and manufacturing tools significantly more expensive to build and install. They are, however, investments that we must make to ensure the company's long-term growth and profitability."⁴⁶

There will likely be some impact on industry R&D conduct as the DoD efforts change. In 1990, RDT&E outlays were about 12% and procurement about 27% of the DoD budget. In 1995, these are projected to be about 14% and 24%, respectively.⁴⁷

All of the companies studied spent three percent or better of sales for R&D. All of the money spent was not necessarily internal company funds; some was from customers. For the group of companies, 8.7% of total sales was committed to R&D. Figure 1 provides the ratio of R&D to sales.

General Attitude

General attitude is difficult to define and to describe. It can apply to an individual in some specific circumstance, but is hard to associate with a group of companies in an industrial segment. With that disclaimer, I think that, in general, the industries, their leadership and the people who do the work, have reasonably positive attitudes towards their companies, communities, customers and competitors. Raytheon is involved in a number of educational programs in the communities in which it is located. In 1990, Boeing corporate gifts totaled \$23.7 million. The largest portion of Boeing corporate contributions went to support education.⁴⁸ At Rockwell, "This also involves building on our culture; a culture where the application of progressive management practices and the continuous challenging of the status quo are the rule. The principles of that culture are set forth in the Rockwell Credo, which is a distillation of management practices and beliefs we have evolved over more than a decade. Intense focus on customers and broad employee involvement form its core."⁴⁹ Rockwell is also involved in a number of programs to promote education.

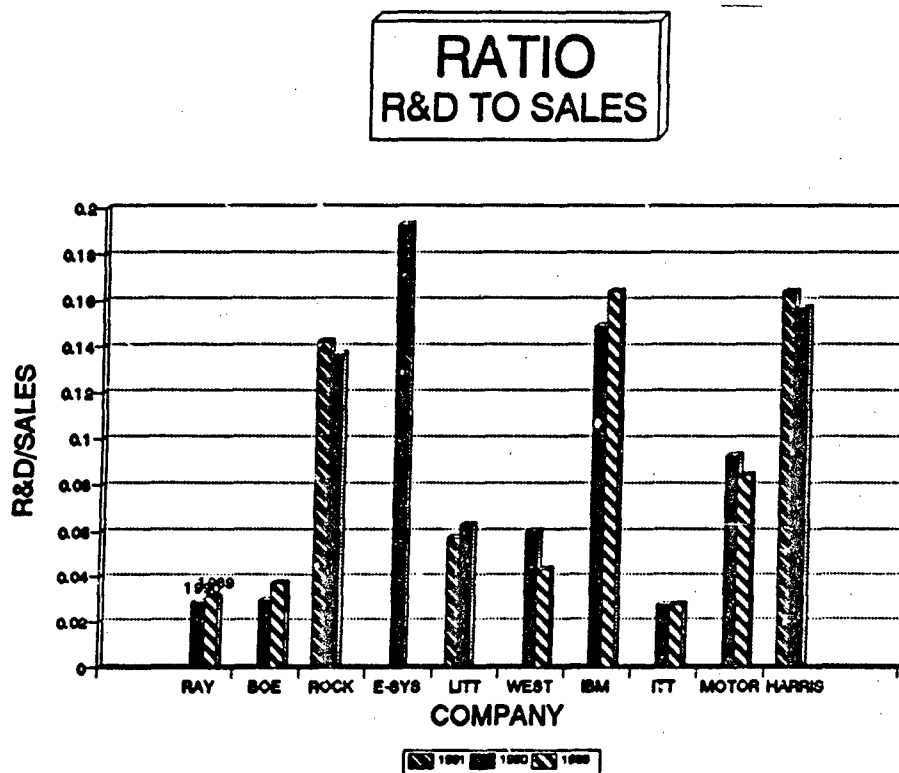


Figure 1. Ratio of R&D to Sales.

Management Strategies (Long-Term Versus Short-Term)

American management has been routinely criticized for short-term thinking. In this industry, as the following will show, management is committed to building shareholder value. External factors, such as: changes in the tax code, revaluation of real estate, and high cost of money, have had a significant impact on business decisions. The end of the 1980s may have been an aberration in the conduct of business and I am confident the future will prove that not only the industries on the forefront of technology are moving in the right direction in an international economy, but also some of the older, more challenged industries, like steel and auto making.

As Motorola reports, "Operating profits were \$225 million, down from \$302 million in 1989. The decline was due to:

- Increased research and development costs for a broad mix of emerging opportunities in radio frequency (RF) communications, as well as expansion for traditional RF products. We believe these investments will provide favorable returns.

- Continued development of the radio data communications business, which promises to rapidly augment our voice and paging technologies. We intend to lead in RF data communications, just as we have led in the growing voice communications businesses.

- Expansion of international distribution channels to meet the growing worldwide popularity of our products and services. We moved aggressively into new markets as their windows of opportunity opened. We believe the potential, both short- and long-term, is significant."⁵⁰

Boeing explains, "Our long-range mission is to be the number-one aerospace company in the world, and among the premier industrial firms, as measured by quality, profitability, and growth. To realize that mission, we are committed to making steady, incremental improvements in the way we design, build, and support our products. We are examining every aspect of our internal processes--from manufacturing to business systems--to look for better ways to get the job done. Our overriding goal in all these continuous improvement efforts is to meet the requirements and expectations of our customers--on whom the company's success ultimately depends."⁵¹ At Boeing, the Defense & Space Group will concentrate its efforts on winning development and production contracts in its existing product lines. The Defense & Space Group comprises three primary product areas: aerospace and electronics, military airplanes, and helicopters. The increase in sharing resources and technology among the product areas is improving the group's ability to cut costs and compete more effectively.⁵²

The last sentence in the Rockwell credo is: "We believe the ultimate measure of our success is the ability to provide a superior value to our shareowners, balancing near-term and

long-term objectives to achieve both a competitive return on investment and consistent increased market value.⁵³

Litton upper management is quoted, "Litton's future growth will continue to come primarily from our worldwide commercial efforts. Our solid financial base enables us to reinvest in the Company through capital expenditures and research and development, to seek out acquisitions on a selective basis, and to take advantage of strategic opportunities which will continue to enhance shareholder values."⁵⁴

Westinghouse states its commitment, "Over the past ten years, your management has adhered to a consistent policy of operating Westinghouse as a value-based corporation. Every major decision is based on how the result will improve our value."⁵⁵ We are determined to maintain a strong competitive position in our markets around the world. We are fully confident of our ability to create outstanding returns for our shareholders, over the long term."⁵⁶

ITT reiterates the above, "We have introduced new leadership at the highest levels of the Corporation. We put in place, in 1989, an Employee Stock Ownership Plan to ensure that our salaried U.S. employees are further motivated to produce results for the company, and to share in its success."⁵⁷ Despite the magnitude of worldwide political and social changes during the recent past, ITT Defense remains committed to the defense industry. ITT Defense continues its commitment to the development and production of quality for the defense industry. As in preceding years, we will continue to pursue this goal through emphasis on process control, reduced cycle times, and aggressive employee training and involvement to achieve greater customer satisfaction and an improved leadership position in key defense industry markets."⁵⁸

Harris states, "Quality First is our strategy for achieving the goal of world-class performance. It is our name for a set of initiatives that blends the ideals and values of total quality management and productivity improvement into the unique culture of Harris.

Through this emphasis on quality in the broadest sense, we intend to achieve superior levels of customer satisfaction, continuous improvement in productivity and quality and growth through new products and systems."⁵⁹

"To position itself to effectively compete in the information processing industry of the 1990s, IBM has intensified its focus on customers. The company's objective is to be the world's champion in meeting customer's wants and needs. The framework of IBM's strategy in the future is market-driven quality. It is a carefully structured framework to identify customer and market needs and to meet those needs with defect-free products and services developed and delivered on a timely, competitive basis. It also calls for increasing individual authority; continually examining and improving business processes and measuring and assessing the process. Market-driven quality really boils down to the very heart of IBM's culture: its basic beliefs in the best customer service, excellence in everything the company does, and respect for individuals--customers as well as employees. The goal is total customer satisfaction."⁶⁰

Thus, a number of companies appear to have a long range view of their business. A major theme in corporations that have survived over a long period is that their most important goal is to enhance shareholder value. That strategy only benefits in the long run. Over the years most companies envision their owners enjoying an increase in wealth.

This does not say that decisions are not made on the basis of financial considerations. In considering net present value of precious capital it may be better to acquire a smaller company than to increase plant size or modernize equipment. Nor does it mean that all decisions taken in the long term will prove correct.

Capital Investment

The companies that make up this segment invest a good deal of capital in their infrastructure. As mentioned above, Boeing invested \$1.6 billion in new equipment and

facilities in 1990. Rockwell says, "We have continued our high level of investment in new products and the tools of productivity that enable our people to work better and smarter."⁶¹

Figure 2 shows the ratio of capital expenditures divided by total sales. Most of the companies invest around four percent in plant or equipment. Motorola stands out with investment of over 11% in 1990 and 1989. The total investment over total sales for all of these companies is six percent.

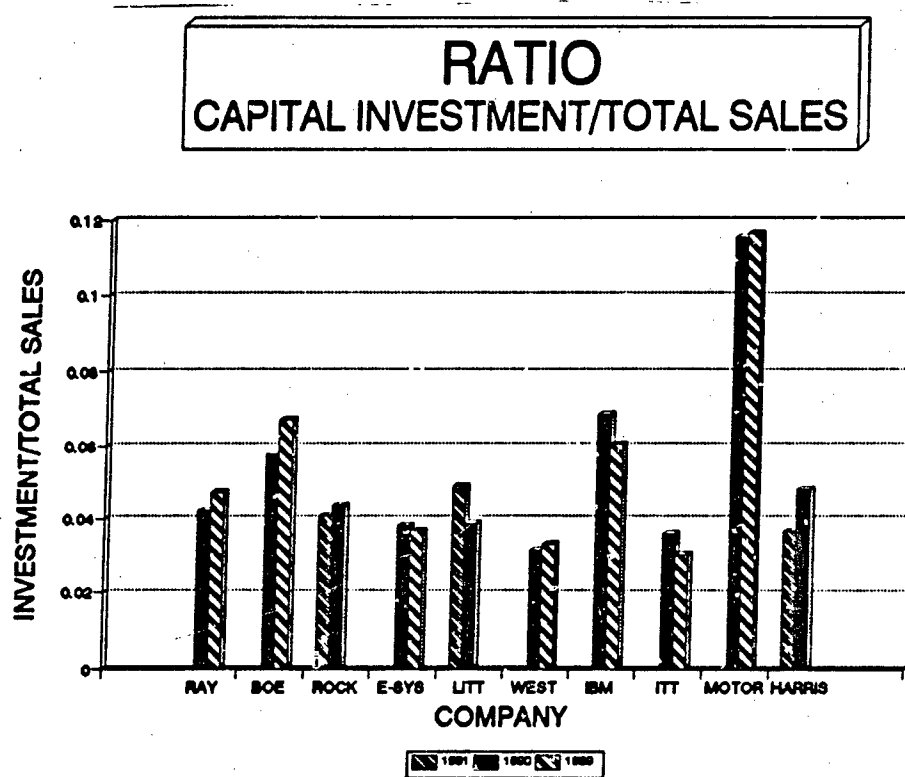


Figure 2. Ratio of Capital Investment to Total Sales.

Mergers and Acquisitions

I was surprised by the activity of the companies studied in mergers and acquisitions. For Raytheon, in commercial electronics, acquisitions and restructuring helped strengthen the company for domestic and global competitiveness.⁶² At Rockwell, income for the year

includes a fourth quarter after-tax gain of \$203 million from the sale of the Network Transmission Systems Division.⁶³ E-Systems said, "Early in October we completed the non-dilutive acquisition of HRB Systems, Inc. HRB Systems designs and develops signal collection, processing and analysis systems, which complements and expands our solid position in the advanced intelligence and reconnaissance systems market."⁶⁴

For Harris, the acquisition of GE Solid State in late 1988 brought together four semiconductor businesses--Harris, GE, RCA and Intersil. Harris Semiconductor's primary focus is on advanced integrated circuits and discrete semiconductors for signal processing and power control applications in commercial and government markets. Harris introduced more than 150 new products to these markets in 1991, and is bringing these products to market faster and at lower cost.⁶⁵ IBM states, "IBM alone cannot address every customer need. So, the company is pursuing joint ventures and alliances with other companies that have specialized skills, technologies or marketing capabilities that complement its own. To reach more customers, IBM also has enlisted the services of more than 5000 business partners worldwide to market and enhance IBM products, software and services."⁶⁶ Standard & Poor's reports, in March, 1991, GTE completed a merger with Contel Corp. in a stock transaction valued at \$6.6 billion. In addition to increasing telephone operations, the merger resulted in GTE becoming the nation's second largest cellular company.⁶⁷ Possibly to prevent a hostile take-over, Litton has an ongoing stock buyback program. Conceivably for the same reason, Watkins-Johnson is repurchasing a substantial number of its shares.

Mergers and acquisitions are a fact of big business. In this sector, all of the activity in the past couple of years is within the same industry. In many acquisitions in the early- to mid-80s the large companies diversified into new areas with purchases of financial management companies, furniture companies and appliance manufacturers (which isn't too far afield!), for example. This practice did not continue, probably because upper management lacked the expertise to manage the new ventures.

PERFORMANCE

Probably the most important consideration for the radio communications industry is its performance. Since this study is not comparative, the reader will have to make final judgement on the health of the segment. I will offer opinions, but will only hypothesize, not provide proof. Facts and figures will follow; appendix A is provided as a short tutorial for many of the accounting terms I will use.

Trends in Sales

The second largest category in SIC 3663, Radio Communication and Detection Equipment, representing about 27 percent of total product shipments by this industry, is communications systems and equipment, except broadcast. This category includes fiber optic systems, microwave and satellite communications systems, paging equipment, and mobile communications systems. Shipments increased 11%, from \$13.8 billion in 1989 to an estimated \$15.0 billion in 1990. This is the fastest growing segment of the radio communication and detection equipment industry. Leading growth areas include cellular, mobile, and satellite communications systems.⁶⁸ According to the Industrial Output Effect of Planned Defense Spending, 1990-1994, The Radio and TV communication equipment segment is expected to decline about 12.6% in total output from 1990 to 1994. Communications, excluding Radio and TV communication equipment is expected to increase 19.3% over the same period.

Current estimates by the EIA are that in 1991 the membership will produce some \$283 billion of U.S. factory sales, while employing nearly two million Americans. Equally important, members will export more than \$70 billion of product to other countries.⁶⁹

Boeing appeared to have some problems: "While the company had a strong year overall, our defense and space operations continues to experience technical, cost and schedule problems on several programs. Although some improvement has been achieved, a substantial net loss on this segment of our business was incurred for the second consecutive year."⁷⁰

Rockwell feels that new Telecommunications products expected to generate growth better than the industry average through 1995. "Defense Electronics' current backlog provides for sizeable sales over the next five years. We anticipate new orders in domestic and international markets will provide modest growth."⁷¹

At E-Systems for the third consecutive year sales and earnings reached record highs.⁷² E-Systems had a strong increase in new orders, largely for classified signal intelligence collection and processing programs in recent years, bringing the backlog to historically high levels. This should support further earnings improvement in 1991.⁷³

Westinghouse reports, "While the defense market segment will be flat or down for the first half of the 1990s, non-DoD markets are expected to grow 15% to 20% a year. The non-DoD part of our Electronic Systems business rose from 23% to 27% of the group's sales in 1990."⁷⁴ With products used from underseas to outer space, the group's (Electronic Systems) defense and non-defense programs expect continued growth in the 1990s. Key to that growth will be accelerated activity in the non-defense arena. In the past 12 months, the non-DoD portion of the group's business has grown from 23% to 27% of sales. To achieve this increase, the group has leveraged its expertise in defense technology into a commercial market base of surveillance systems, aircraft accessories and information systems.⁷⁵ Electronic Systems sales increased 8% which reflects growth in production programs. Operating profit increased 67% due to the inclusion of restructuring provisions of \$74 million in 1989. Excluding restructuring, operating profit increased 21% due primarily to higher revenues and increased operating profit margins."⁷⁶

Harris complains, "Fiscal 1991 was a difficult and disappointing year for our company. A combination of recessionary market conditions, economic disruptions associated with the Gulf War, and an after-tax charge of \$72.9 million taken in the second quarter in connection with the restructuring of our Semiconductor Sector resulted in significantly lower earnings for the year. The Communications Sector also reported significantly lower earnings

on flat sales. In addition to the effects of a weak U.S. economy, earnings in this sector were impacted by the substantial legal expenses incurred in defending against a Justice Department foreign-practices charge that was dismissed by a federal court."⁷⁷

Quality of Products

This segment of telecommunications produces highly differentiated, relatively low volume equipment. That does not automatically mean quality, but all evidence points to that.

At E-Systems, "The Data Distribution System is a US Navy program for a high data rate, secure and jam-resistant distribution system among various weapon systems within a task force group. We developed the shipboard equipment and provided support for an at-sea capability demonstration in mid-1990. Under contract with the U.S. Navy, deliveries began in 1990 of improved designs of the AN/WSC-3 shipboard radio used for line-of-sight and satellite communications. Continuing production contracts were received for the U.S. Navy standard UHF/VHF transceiver, the AN/ARC-182.⁷⁸ Another contract was awarded for the insertion of digital microelectronic GaAs chips into a modem and synthesizer for the U.S. Army's small unit radio. The radio will provide anti-jam frequency-hopping capability and compatibility with the single channel ground and airborne radio system(SINCGARS)."⁷⁹ I know from personal experience that the AN/WSC-3 and the SINCGARS systems are both high-quality, reliable equipments.

Litton won additional funding for the production of hand-held digital communications terminals for the Marines, Army and Air Force and for lightweight automated artillery fire-control systems for the Army and Marines.⁸⁰ I am also familiar with this rugged, reliable and effective system.

During the conflict (Desert Storm/Shield), the coalition forces, and particularly those of the United States, employed high quality ITT equipment--from field radios to countermeasure devices, night vision goggles and seagoing radars.⁸¹ ITT was the developer of the SINCGARS radio system for the Army. ITT Defense remains a leader in the military

communications market and, in 1990, achieved a number of milestones. The 20,000th Single Channel Ground and Airborne Radio System (SINCGARS) was delivered to the U.S. Army. The Defense Acquisition Board also has authorized production to proceed at the full rate of over 1,000 radios per month beginning in 1991.⁸²

Harris won significant contracts for military ground-based communication systems in fiscal 1991. These included a \$40 million contract from the Army for new, man-portable communication systems for its Special Operations Forces.⁸³

The companies producing radio communications equipment are capable of quality. The systems they sell to the military have reputations for quality and durability. The next section will further demonstrate high quality.

Export Competitiveness

Communications firms have begun to look toward the international and civilian markets for new contracts in radio communication and detection equipment. Many countries in regions such as South America, Southeast Asia, Southern Europe and especially Central and Eastern Europe, are in desperate need of modern communications equipment as they begin to upgrade their civilian aviation and communications systems.⁸⁴ The major foreign markets in 1990 were Canada, 11%; Japan and the United Kingdom, 10% each; Mexico, 9%; and Germany and Brazil, 4% each. These six countries accounted for nearly half of total U.S. exports. The most significant product exports were parts for radio telegraphic and telephonic equipment, accounting for 17% of the total and communications satellites, 12%. For imports, Japan continued to be the largest foreign supplier in 1990, accounting for nearly 30% of the total. The changing geopolitical climate may allow new markets to open for the defense communications industry. The Coordinating Committee on Multilateral Export Controls (COCOM) will probably further relax export restrictions on sales of radio communication and detection products to Central and Eastern Europe as countries in these regions continue to enact political reforms and move closer to market-oriented economies.

Many of these countries are in dire need of improved aviation and communications equipment to replace their antiquated systems.⁸⁵

According to Motorola, "Our customer base has become more global, and we are expanding accordingly. Non-US revenues as a percentage of the total reached 44% in 1990, compared with 25% in 1985, on an international market basis. In Japan our MicroTACtm personal cellular telephone won the Foreign product Design Award from the Ministry of International Trade and Industry. Our speech coder technology was selected as the official standard for digital cellular in Japan. In Asia, we opened a major new semiconductor facility in Hong Kong, provided the radio system for the Asian Games in China, and shipped more than 500,000 pagers to Taiwan. We won awards for cellular phone systems in Indonesia and China. In India, our Motorola Blue Star joint venture produced its first data communications products. In Europe, we will supply the communications for the Channel Tunnel linking England and France."⁸⁶

Rockwell states, "In telecommunications we are the world leader in fax and data modems and in switching systems to handle large volumes of telephone calls at telephone companies, airlines, hotels, telemarketing bureaus and similar high call volume businesses."⁸⁷ Our digital communications business marked its 30th year in modem technology. It currently holds the major share of this global market with 25 million devices installed. By providing superior technology, quality and reliability we have become one of the few American companies to sell high volumes of US made electronic devices into Japan. In 1991, the Sharp Corporation presented the Shoutoku Hayakawa Memorial Award to Rockwell for outstanding contributions to Sharp's business. We are the first non-Japanese company to receive this honor. Also, in its Spring/Summer 1991 issue, Fortune magazine hailed the Rockwell facsimile modem as one of the products '...America makes best.'⁸⁸

E-Systems submits, "Another factor which is expected to contribute to the Company's growth is increased international sales. In 1990 and 1989, international sales were 7 and 10

percent of total sales, respectively. We expect this area to grow to as much as 20 % of sales over the next several years, although there are difficulties in exporting sensitive high technology abroad."⁸⁹

Westinghouse had international market penetration increase to 23% of sales.

Harris feels, "Developing areas such as Asia, Central and South America, the Middle East and Africa are still building their communications infrastructure and represent good growth opportunities for Harris communications products and systems. The company has become very good at working with the varied government laws and different cultures inherent in these markets. International sales represented 40% of the Communications Sector's total in 1991, compared with 30% the previous year."⁹⁰

IBM is certainly known as an international company. "IBM has long been among the most international of companies, a significant advantage in an increasingly global marketplace. During 1990, we expanded our initiatives in Eastern Europe and moved the headquarters of our Communication Systems line of business from New York to London in order to better respond to customer needs in the fast-growing European telecommunications arena."⁹¹

The EIA is involved with helping U.S. businesses operate in the international environment. The International Business Council held three major conferences on doing business in Eastern Europe and the Soviet Union.⁹² The Export-Import Committee of the Government Division developed and presented views on defense electronic export issues to the departments of State, Commerce and Defense, leading an industry-wide effort which proposed a major revision of the International Trade in Arms Regulations.⁹³

Figure 3 shows the ratio of overseas sales to total sales of the companies studied in this report. All of the companies sold six percent or more to foreign customers in the years shown. More than half of the sales of Boeing and Motorola were to foreign customers. The ratio of overseas sales to total sales for this group of companies is 35%.

Are the Companies Asking for Protection from Foreign Competitors?

I have found no evidence that any company or trade association in this segment is asking for protection from foreign competitors. It appears that even if the companies do not relish foreign competition, they are involved in it and are doing their best to compete globally.

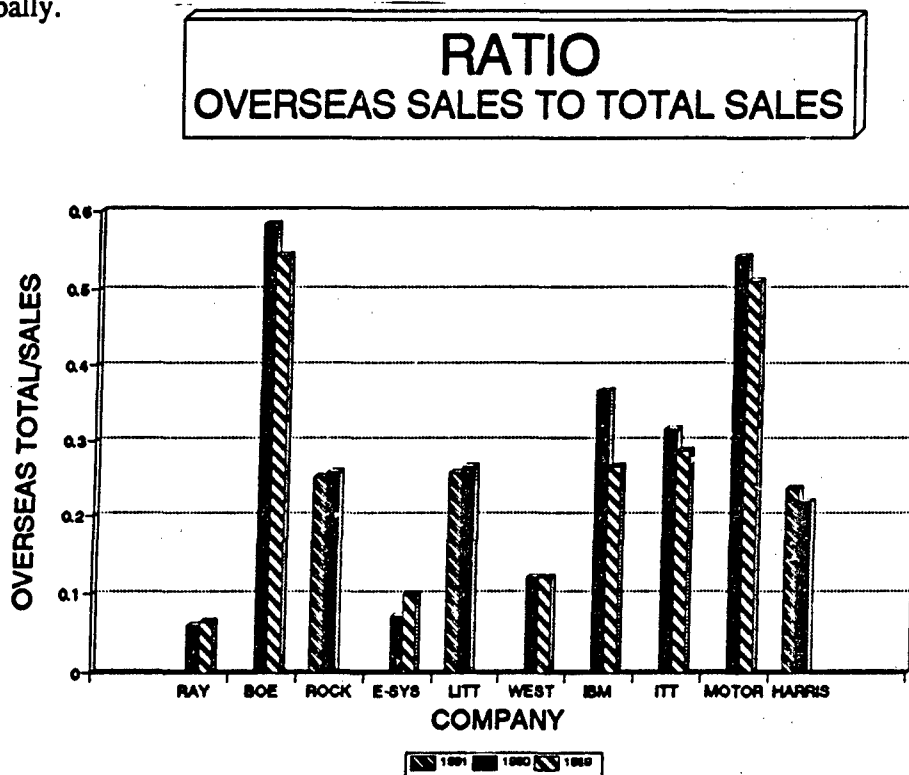


Figure 3. Ratio of Overseas Sales to Total Sales.

How is the Private Sector Responding to DoD Budget Cuts?

According to a report, Lifeline Adrift, sponsored by the Air Force Association, a major element of the new U.S. defense strategy is "reconstitution of forces," which the Joint Chiefs of Staff believe "may well prove to be the linchpin of America's long-term security." The strategy assumes that smaller standing forces of the future can handle all except the most extreme contingencies with existing equipment and stocks, that there would be ample warning

time to prepare for conflict of greater intensity, and that the armed forces and the supporting industry will be able to respond adequately.

In the Gulf War, which would rate as a "major regional contingency" under the new strategy, logisticians and suppliers worked at a punishing pace during the five months they had to get ready. U.S. forces entered the fight with excellent stock levels, built earlier when requirements included meeting a major Soviet threat in Europe. To considerable extent, policy is being established by default. The approach amounts to letting the market fires burn themselves out, then seeing what can be made of whatever is left.

As a practical matter, commercial demands in the market overshadow defense requirements, so the government has limited leverage. Its options are also constrained by a shortage of funding that might be applied to the problem.

The Administration staunchly opposes "Industrial Policy" and believes that the shape of American industry should be left for market forces to decide. This doctrine--which applies not only to the domestic consumer economy but also to defense industry and international trade--essentially allows the defense industrial base to drift where the market takes it.⁹⁴

In general, the segment is trying to move more and more to commercial and international markets. They are diversifying to non-military products and are looking to military sales overseas. Standard & Poor's states, "Most military contractor's have reacted quickly to the diminishing military market by cost cutting and other measures. It is likely that these conditions, plus a revival in the commercial market, will produce some further earnings improvements in 1991. Over the longer term, however, we continue to view the defense industry as being in a downtrend, caused by shrinking defense budgets. With some exceptions, lower sales and earnings are likely for defense contractors in the next few years".⁹⁵

Firms in the communications and electronics fields may be least affected by defense cuts. A majority of the cuts proposed are geared toward nuclear weaponry and strategic

hardware that most communications and electronic firms do not directly manufacture.

However, given the Defense Department's objective of reducing the defense budget 25% by calendar year 1995, it is safe to say that all firms with interests in the defense field will feel the effects of smaller defense budgets.⁹⁶

Between 1990 and 1994, only six of the top 28 defense industries will suffer reductions of 10% or more in their total output, defense and civilian. For most industries, expected increases in demand from civilian markets, including exports, will compensate for the declines in output associated with defense demand.⁹⁷ Within the defense sectors, planned reductions in defense outlays will reduce output requirements for virtually every industry. For most of these industries, however, modest improvement in the economy after two years of relatively low growth and the conversion of production for defense to non-defense uses will generally compensate for anticipated reductions in defense demand.⁹⁸

The Report to Congress on the Defense Industrial Base, Nov. 1991 reported that electronics spending will also be reduced but the impact will be eased by the industry's large commercial sales base, which includes both foreign and domestic customers. Nevertheless, industry has made considerable effort to enhance itself through divestitures and acquisitions as a means of insulating itself from any negative effects of budget cuts. Two types of firms produce electronics required by DoD: "defense electronics" firms that depend heavily on DoD sales, and "commercial electronics" firms that produce primarily for the commercial market but also for defense. Both frequently act as subcontractors to the large primes. Most electronics companies with DoD business are relatively strong financially, and these are backed by hundreds of other electronics firms that could potentially meet expanded DoD requirements if conditions were to change in the future. DoD continues to modify its acquisition practices to stimulate commercial firms to conduct business with DoD. As a result, the industrial base for electronics will be more than adequate to support DoD program needs as defined by the current and projected budget.⁹⁹ In contrast to the procurement

reductions. RDT&E funding (in real dollars) will increase in the near-term, from \$35.5 billion in FY91 to \$36.8 billion in FY 93. Even with the moderate declines planned for the outyears, RDT&E funding will show a steady increase relative to the procurement share. This RDT&E funding base will provide for the continuation of essential R&D activity, even as production is reduced.¹⁰⁰ The budget for stand-alone electronics (the electronics and communications equipment category) is expected to decline by less than 10% between FY90 and FY93. There is a significant overlap between the commercial and defense markets in terms of products and producers, but defense items tend to be specialized and are frequently produced separately.¹⁰¹

The companies seem to be optimistic in the present budget climate. E-Systems says, "Defense electronic budgets in general and the electronic warfare segment in particular are expected to fare better than other areas in the defense environment. As the United States withdraws forces or weapon systems in particular areas of the world, greater emphasis will have to be placed on intelligence collecting and processing, which we believe will have a positive impact on the Company's growth."¹⁰² At Litton, it is expected, therefore, that electronics will command a better share of defense budgets, particularly since they allow governments to extend the lives of existing platforms, such as helicopters, ships and fixed-wing aircraft, through modernization and upgrades.¹⁰³

Environmental Concerns

Many of the companies I have studied stated they were concerned with the environmental impacts of their industrial activities. Their largest problems are encountered on the production lines of products other than communications equipment. This segment does not generate additional significant problems.

Associated environmental concerns are the limitations of radio spectrum and the impact of interference on the use of radio communications equipment. This is a technical problem inherent in the physics of electro-magnetics. It also is a major international political

problem. This year, 1992, the World Administrative Radio Conference met from Feb. 3 to Mar. 3 at Torremolinos, Spain, to deal with frequency allocation in the radio spectrum.

Legal Problems

A few of the companies experienced legal problems in the past few years. This is not an unusual problem, but a large award or fine or other adverse action can seriously affect a company's performance.

At E-Systems, The Company discontinued the operations of its Memcor Division, where certain Government contracts for the production of VRC-12 series tactical radios had been terminated for default on December 31, 1985 by the U.S. Army Communication and Electronics Command. The company had a number of claims for equitable adjustment of the contract prices and claims relating to the termination of the contracts. The discontinued Memcor Division became the subject of a criminal investigation in early 1988 related to the terminated contracts and other alleged activities of the Division. On August 27, 1990 the Company pleaded guilty to a three count criminal investigation, charging that it and others had conspired to falsify records of the test results on the tactical radios produced at the discontinued Memcor Division's now closed Bushnell, FL, manufacturing plant and the Company agreed to a \$2 million criminal fine and \$1.8 million in restitution. Finally, as of August 27, 1990, the Company and the U.S. Department of the Army entered into an agreement which provided that the Company is a presently responsible contractor and will not be subject to administrative action as a result of the matters previously described.¹⁰⁴

Other companies were involved in less critical legal actions.

Financial Performance

There are few generalities in financial performance. A viable industrial area like that of radio communications will have companies which are doing well and some that are doing poorly. Following will be a detailed description of the financial performance in this segment.

Motorola said, "Sales increased 13% in 1990, but earnings were about the same as in 1989. Some stockholders and analysts believe we are over-investing in research and development and pursuing too many technologies in our strategic areas of interest. We respectfully disagree and believe that sustained, long-term investments in promising technologies provide the platform for solid, profitable growth."¹⁰⁵ At Raytheon, "Raytheon performed well in 1990, setting new records for earnings, sales and earnings per share for the sixth year in a row. Return on average equity was 21.2%, the fourth year in a row it exceeded 20%."¹⁰⁶

Standard & Poor's Corp Stock Market Encyclopedia contains information on the performance of a large number of companies. Here are some of the comments about specific firms:

- Of the companies studied only Boeing had five straight years of rising earnings.
- IBM has a relatively low P/E with high yields.
- GTE is ranked in the group of companies which yielded higher dividends for the past ten years.
- HARRIS--Earnings for the first nine months of fiscal 1991 were impaired by weaknesses in domestic semiconductor markets and restructuring costs in that segment. However, plant consolidations, headcount reductions, and the discontinuance of marginal products, coupled with an anticipated economic recovery, should lead to earnings improvement in fiscal 1992.
- MOTOROLA--The impact of a recession in the U.S. and continued high levels of investment spending is likely to cause a small earnings decline in 1991. Sales for 1991 should increase slightly, led by continuing strong growth in cellular mobile telephone systems. Communications sales should also be higher.

■ RAYTHEON--Newer contracts and international sales should expand Raytheon's important missiles/defense electronic business despite the general weakness in defense spending. Higher earnings are expected for 1991.

Standard & Poor's stock group performances for second quarter 1991 ranked the Communications-Equipment/Manufacturers number seven, with percentage increase of 12.8 and the Telecommunications(Long Distance) number eight, out of 93 stock groups. Aerospace/Defense ranked number 49 with a decrease of 0.5 percent.¹⁰⁷

S&P uses a couple of devices for comparing financial performance of companies, beta and a common stock ranking system.

The beta relates the volatility of a single stock to the volatility of the market as a whole. An issue with a beta of 1.5, for example, tends to move 50% more than the total market, in the same direction. An issue with a beta of 0.5 tends to move 50% less. If a stock moved exactly as the market moved, it would have a beta of 1.0. Thus, high beta is typical of a volatile stock. Low beta is typical of a stock that moves less than the market as a whole. A stock with a negative beta moves in the direction opposite to that of the market. With a beta of -1.0 a stock has the same volatility as the market, but tends to rise when the market falls, and vice versa. Standard & Poor's uses a five year trading history to determine beta.¹⁰⁸

Standard & Poor's has a common stock ranking system. The system has seven grades: A+, A and A- are above average; B+ is average; B, B- and C are below average. An NR designation (no ranking) is given to common stocks with insufficient historical data or because the company is not amenable to the ranking process because of one or more reasons. The grade D signifies a company in reorganization.¹⁰⁹

Figure 4 is the betas for the companies of interest. All of the companies are clustered around positive one, showing they move in the same direction and at about the same rate as the market.

Following are the Standard & Poor's ranking for the companies:

<u>Company</u>	<u>Ranking</u>
Boeing	A
E-Systems	A
GTE	A-
Harris	B
IBM	A
ITT	B
Litton	B+
Motorola	A-
Raytheon	A+
Rockwell	A+
Watkins-Johnson	B+
Westinghouse	A

All the companies, with the exception of Harris and ITT, have an average or better ranking.

BETA STANDARD & POOR'S

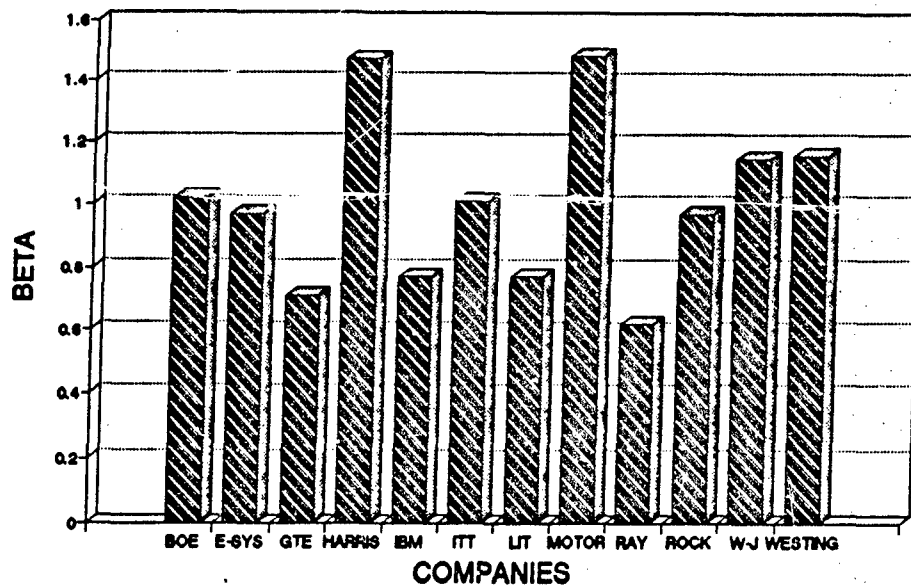


Figure 4. Standard & Poor's Betas.

Figure 5 provides the price/earnings ratio for the companies. All but Harris and Westinghouse are between eight and 15.

P/E RATIO STANDARD & POOR'S

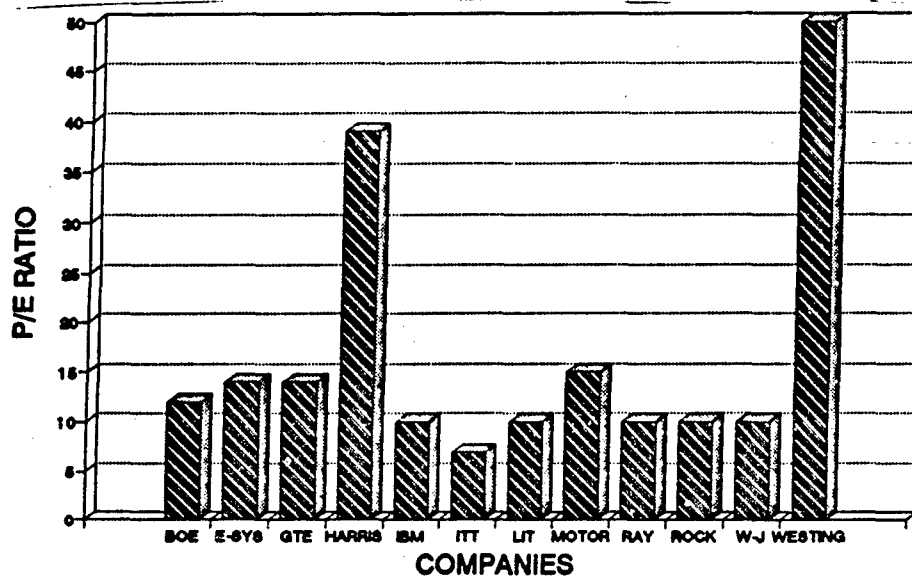


Figure 5. P/E Ratio.

The next figure, figure 6, shows high and low stock prices for the year ending in June, 1991.

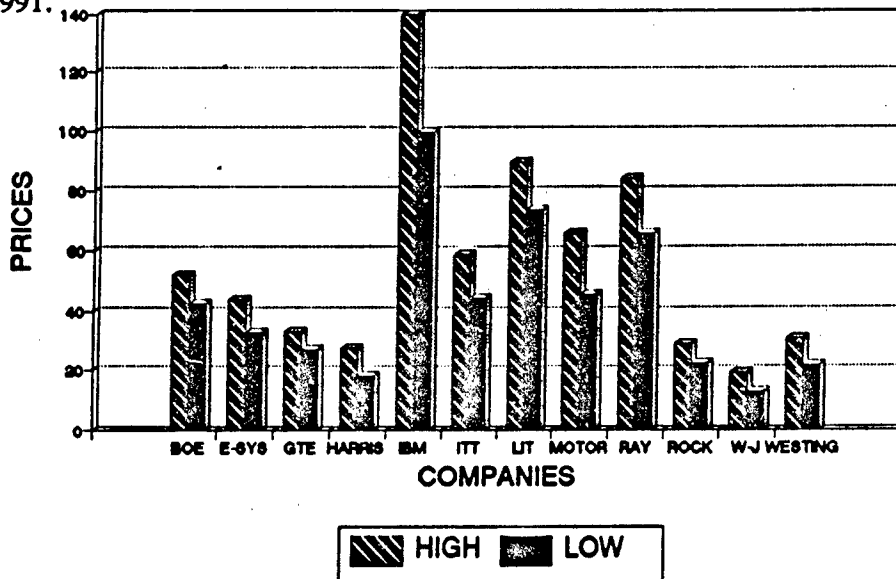


Figure 6. Stock Prices.

Figures 7 through 12 provide various financial indicators from the companies.

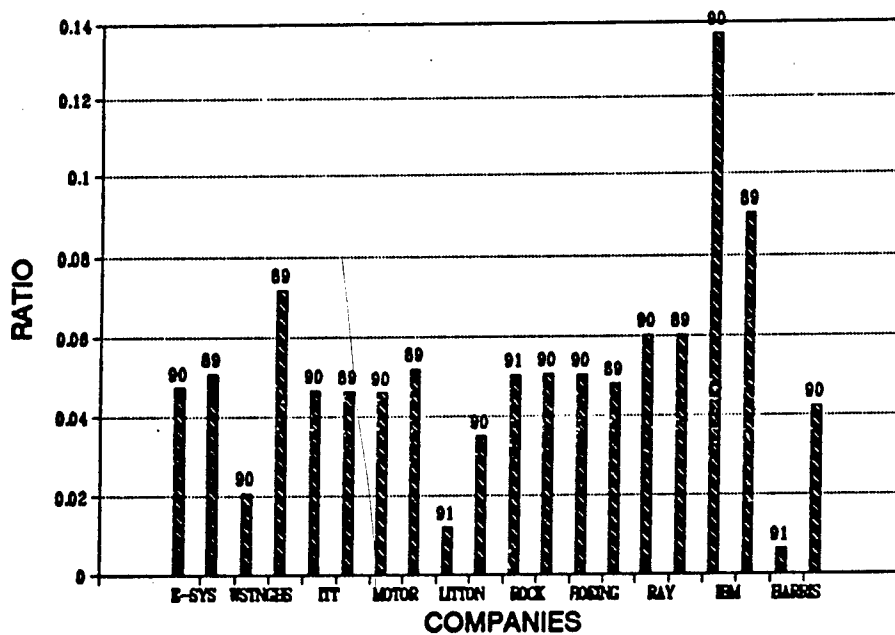


Figure 7. Profit Margin.

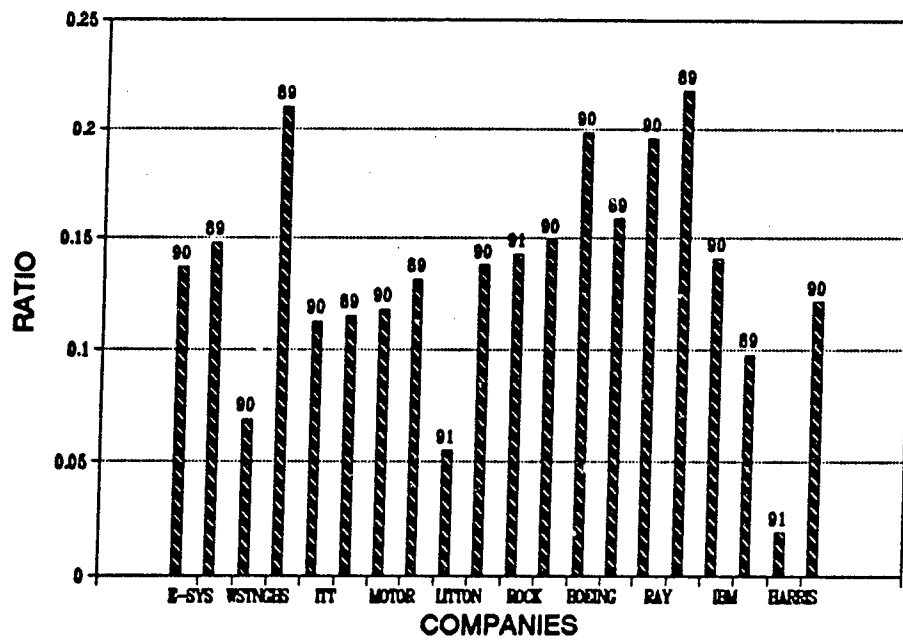


Figure 8. Return on Equity.

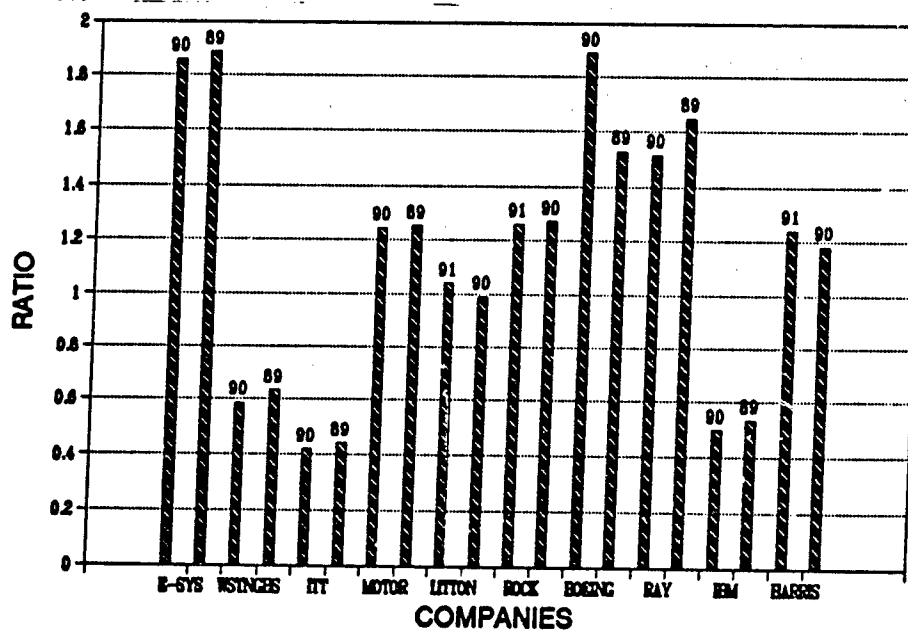


Figure 9. Return on Assets.

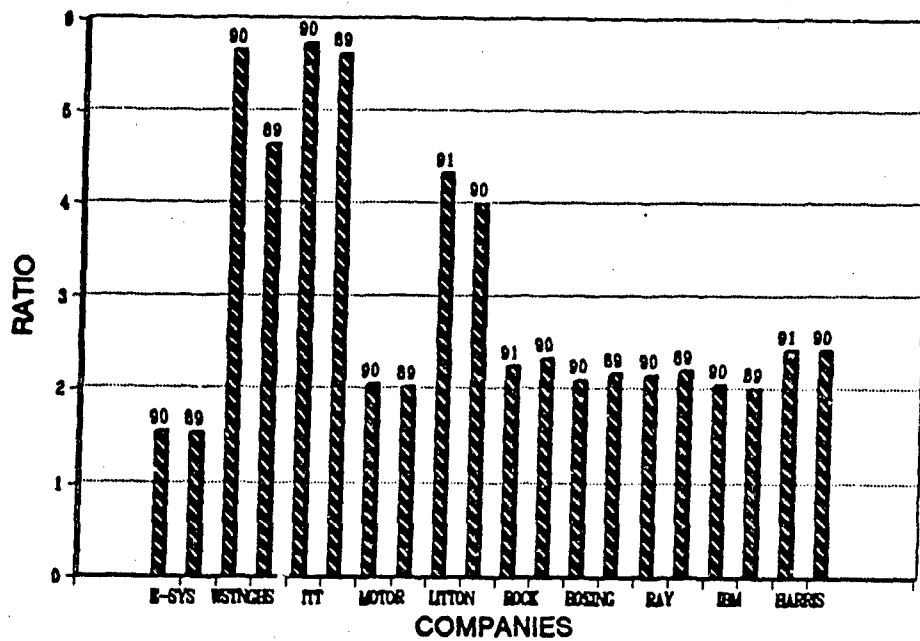


Figure 10. Financial Leverage.

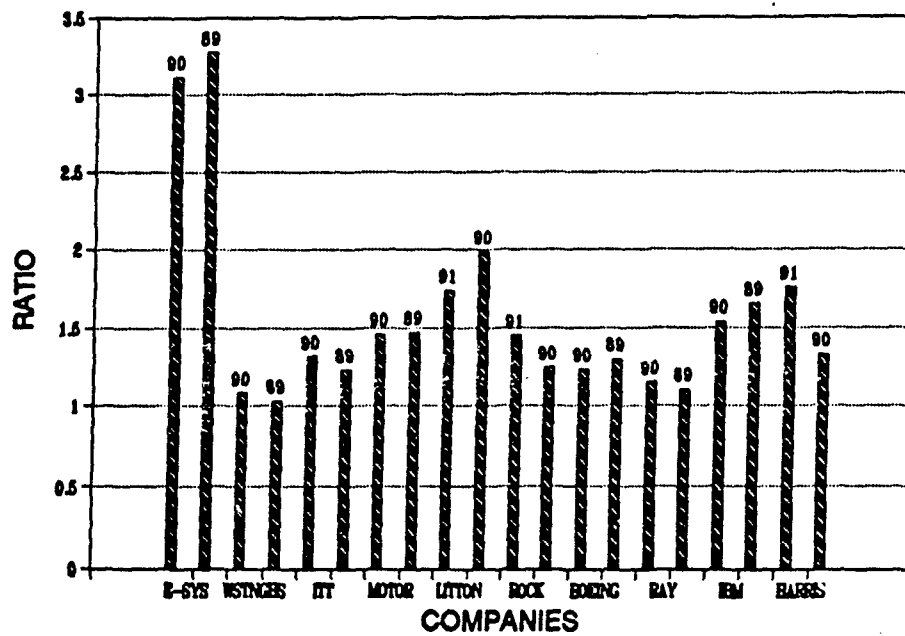


Figure 11. Current Ratio.

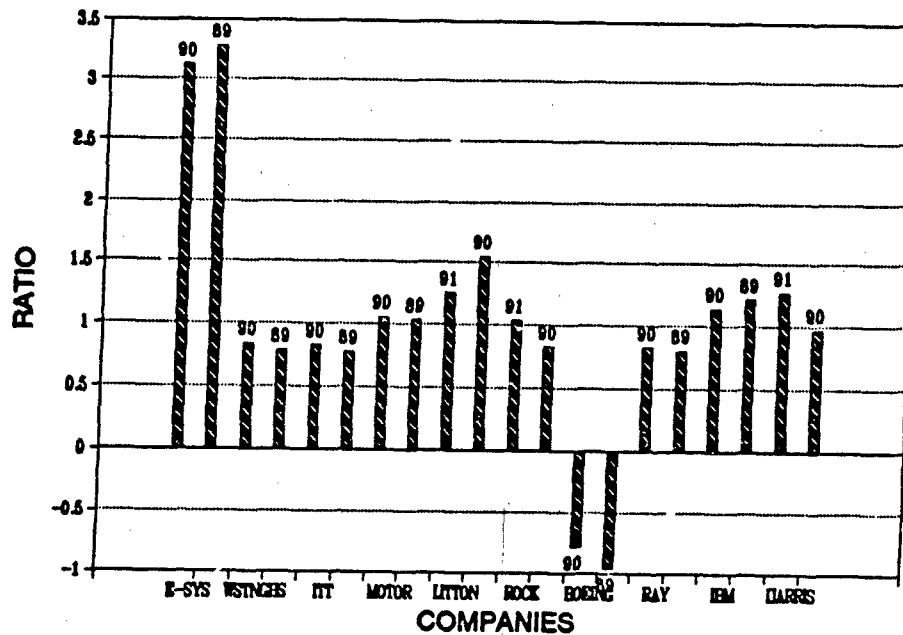


Figure 12. Acid Test.

The above graphs can offer insights into the financial health of a firm. They do not provide any absolute information, but, rather, raise questions which may require further study to find an answer. It is interesting that, for the most part, the companies tend to have similar numbers, with a few exceptions for each ratio. Also, the individual companies do not vary greatly from year to year.

GENERAL COMMENTS

There is some additional data that does not fit in the categories above, but is of interest in a baseline study of the industry. The EIA Tax Council conducted an extensive survey of industry opinion on legislative and regulatory issues. The results reflected the priorities of EIA members in the telecommunications, defense electronics, consumer electronics and component markets and included both large and small company participants. Among the industry's top legislative priorities were (1) the growing importance of preserving current corporate tax rates, (2) the need for a permanent solution to the R&D tax

credit/Section 861 R&D allocation issues, (3) meaningful, long-term federal deficit reduction, and (4) the growing cost of compliance in the areas of employee benefits and foreign tax practice.¹¹⁰ On the legislative front, the Human Resource Council, in conjunction with the Legislative Affairs Council Domestic Committee, actively opposed the Kennedy-Hawkins Employment Quota Bill, joining a multi-industry coalition formed to combat the legislation.¹¹¹

A comment from Lifeline Adrift is pertinent in setting the stage for the long term prospects of DoD as a customer, "The principal caution we offer about critical technologies is that some advocates of this approach believe it is sufficient to perform the research and development (and perhaps build a few prototypes), then shelve the technology without producing or marketing the actual systems or products. In the absence of production, unfortunately, the supporting supply chain and the manufacturing base would wither away. Isolated R&D tends to lose touch with the real world. Leading-edge technology matures by evolution. It takes time and use to work the bugs out of systems. It is naive to expect this maturation to occur in labs and on test benches."¹¹²

APPENDIX A

A study of any commercial industry requires some basic understanding of and familiarity with financial indicators. I have had no formal accounting training and do not intend to go into detail, but rather to present some basic concepts and ratios. *Analysis for Financial Management*, by Robert C. Higgins is an easily understandable book and is highly recommended for those with minimal experience in accounting.

The most basic concept in accounting is that, on a balance sheet:

$$\text{Assets} = \text{Liabilities} + \text{Shareholders' Equity}$$

Shareholders equity is the accountants estimate of the shareholders investment in the business. Shareholders equity appears on the liabilities side of the balance sheet, not the asset side. It represents owners' claims against existing assets. In other words, it is money that has already been spent.

The most popular measure of financial performance amount investors and senior managers is return on equity (ROE), defined as:

$$\text{Return on Equity} = \frac{\text{Earnings}}{\text{Shareholders' Equity}}$$

ROE is a measure of the efficiency with which the company employs owners' capital.

ROE is prone to three problems, the timing problem, the risk problem, and the value problem.

The Timing Problem. ROE is calculated on an annual basis. Should a major capital investment occur during the year, the value of ROE could be low, in spite of a healthy company's investment in the long term.

The Risk Problem. The value of ROE says nothing about how the numbers are achieved, either through high or low risk endeavors.

The Value Problem. ROE uses the book value of shareholders' investment rather than the market value of the stock. A high ROE may not represent a high return on investment to shareholders.

ROE is made up of three principal components:

$$ROE = \frac{\text{Earnings}}{\text{Shareholders' Equity}}$$

$$ROE = \frac{\text{Earnings}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Shareholders' Equity}}$$

In other words:

$$ROE = \text{Profit Margin} \times \text{Asset Turnover} \times \text{Financial Leverage}$$

This means that ROE can be controlled by manipulating three levers:

- (1) The earnings squeezed out of each dollar of sales, or profit margin;
- (2) The sales generated from each dollar of assets employed, or asset turnover, and;
- (3) The amount of debt used to finance the assets.

There are two other similar ratios which are of interest for a basic understanding of a company's financial operating characteristics. They are the Current Ratio and the Acid Test.

$$\text{The Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

It is a crude indicator of how liabilities are matched to assets. If current liabilities were vastly greater than current assets, it would be questionable that a company could meet its financial obligations. Current assets include inventories as a term. A company in trouble may not be able to sell off inventories except at a substantial discount. Thus the Acid Test (or Quick Ratio) removes inventories from current assets:

$$\text{Acid Test} = \frac{\text{Current Assets} - \text{Inventories}}{\text{Current Liabilities}}$$

The above ratios must be used with other information to assess financial health of a company. They provide a jumping-off point for more detailed analysis.

1. "Future Army Systems Flow Via Technical Performance," SIGNAL, (January, 1992), p. 27.
2. Stanley P. Dereska, "Defense Technology Drives New Battlefield Systems," SIGNAL, (January, 1992), p. 47-48.
3. Motorola Annual Report, 1990, p. 19.
4. Ibid., p. 23.
5. Ibid., p. 23
6. Raytheon Annual Report, 1990, p. 32.
7. Rockwell International Annual Report, 1991, p. 1.
8. Ibid., pp. 9-10.
9. Westinghouse Annual Report, 1990, p. 2.
10. Harris Annual Report, 1991, p. 11.
11. Ibid., p. 38.
12. IBM Annual Report, 1990, p. 28.
13. U.S Industrial Outlook, 1991, p. 31-2.
14. Motorola Annual Report, 1990, p. 16.
15. U.S Industrial Outlook, 1991, p. 31-1.
16. Industrial Output Effects of Planned Defense Spending, 1990-1994, Department of Commerce, Office of Policy Analysis, Economics and Statistics Administration, (February, 1991), p. 8.
17. Motorola Annual Report, 1990, p. 16.
18. Ibid., p. 19.
19. Raytheon Annual Report, 1990, p. 3.
20. Ibid., p. 13.
21. Boeing Annual Report, 1990, p. 22.
22. Litton Annual Report, 1991, p. 4.
23. Ibid., p. 30.

24. Harris Annual Report, 1991, p. 2.
25. Signal Magazine, January 1992, p. 17.
26. Raytheon Annual Report, 1990, p. 34.
27. ITT Annual Report, 1990, p. 3.
28. Harris Annual Report, 1991, p. 50.
29. Boeing Annual Report, 1990, p. 3.
30. Electronic Industries Association Annual Report, 1990, p. 1.
31. Ibid., p. 1.
32. Ibid., p. 8.
33. Motorola Annual Report, 1990, p. 2.
34. Raytheon Annual Report, 1990, p. 4.
35. Rockwell Annual Report, 1991, p. 2.
36. Ibid., p. 4.
37. Ibid., p. 5.
38. Harris Annual Report, 1991, p. 5.
39. Ibid., p. 8-9.
40. IBM Annual Report, 1990, p. 26.
41. EIA Annual Report, 1990, p. 7-8.
42. Motorola Annual Report, 1990, p. 24.
43. Raytheon Annual Report, 1990, p. 14.
44. Boeing Annual Report, 1990, p. 2.
45. Rockwell Annual Report, 1991, p. 7.
46. IBM Annual Report, 1990, p. 29.
47. Industrial Output Effects of Planned Defense Spending, 1990-1994, p. 4.
48. Boeing Annual Report, 1990, p. 24.

49. Rockwell Annual Report, 1991, p. 2.
50. Motorola Annual Report, 1990, p. 19.
51. Boeing Annual Report, 1990, p. 3.
52. Ibid., p. 14.
53. Rockwell Annual Report, 1991, p. 21.
54. Litton Annual Report, 1991, p. 5.
55. Westinghouse Annual Report, 1990, p. 2.
56. Ibid., p. 3.
57. ITT Annual Report, 1990, p. 2.
58. Ibid., p. 9.
59. Harris Annual Report, 1991, p. 6-7.
60. IBM Annual Report, 1990, p. 24-25.
61. Rockwell Annual Report, 1991, p. 3.
62. Raytheon Annual Report, 1990, p. 6.
63. Rockwell Annual Report, 1991, p. 1.
64. E-Systems Annual Report, 1990, p. 1.
65. Harris Annual Report, 1991, p. 15.
66. IBM Annual Report, 1990, p. 25.
67. Standard & Poor's Corp Stock Market Encyclopedia, Standard & Poor's Corporation, Vol. 13, No. 3, (New York, NY, August 1991) p. 934P.
68. U.S. Industrial Outlook 1991, Department of Commerce, (Washington, DC, 1991) p. 31-1 to 31-2.
69. EIA Annual Report, 1990, p. 1.
70. Boeing Annual Report, 1990, p. 2.
71. Rockwell Annual Report, 1991, p. 9.
72. E-Systems Annual Report, 1990, p. 1.

73. Standard & Poor's, p. 788.
74. Westinghouse Annual Report, 1990, p. 2.
75. Ibid., p. 8.
76. Ibid., p. 21.
77. Harris Annual Report, 1991, p. 2-3.
78. E-Systems Annual Report, 1990, p. 12.
79. Ibid., p. 20.
80. Litton Annual Report, 1991, p. 7.
81. ITT Annual Report, 1990, p. 2.
82. Ibid., p. 9.
83. Harris Annual Report, 1991, p. 12.
84. U.S. Industrial Outlook, 1991, p. 31-4.
85. Ibid., p. 31-2 to 31-3.
86. Motorola Annual Report, 1990, p. 4.
87. Rockwell Annual Report, 1991, p. 9.
88. Ibid., p. 11.
89. E-Systems Annual Report, 1990, p. 25.
90. Harris Annual Report, 1991, p. 19.
91. IBM Annual Report, 1990, p. 3.
92. EIA Annual Report, 1990, p. 4.
93. Ibid., p. 18.
94. Lifeline Adrift, Report by the Air Force Association, The Aerospace Education Foundation, (Arlington, VA, September, 1991), p. i.
95. Standard & Poor's, no page number.
96. U.S. Industrial Outlook, p. 31-4.

97. Industrial Output Effects of Planned Defense Spending, 1990-1994, p. 1.
98. Ibid., p. 6.
99. Report to Congress on the Defense Industrial Base, Department of Defense, (November, 1991), p. ES-4.
100. Ibid., p. 2-3 to 2-4.
101. Ibid., p. 3-10.
102. E-Systems Annual Report, 1990, p. 25.
103. Litton Annual Report, 1991, p. 4.
104. E-Systems Annual Report, 1990, p. 33.
105. Motorola Annual Report, 1990, p. 3.
106. Raytheon Annual Report, 1990, p. 2.
107. Standard & Poor's, p. 16.
108. Ibid., p. 15.
109. Ibid., p. 18.
110. EIA Annual Report, 1990, p. 4.
111. Ibid., p. 7.
112. Lifeline Adrift, p. 20.